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G1A
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(54) **Proximity sensor**

(57) A proximity sensor (1) has a housing (2) and a detection means (8) placed on an outer face of the housing (2). The detection means (80 is orientated so as to be normal to the length direction of the housing and on the side thereof. The housing (2) is generally cylindrical and a male thread (3) on it. One end of the housing has a flat (7) so as to be in the form of a segment (6) of a cylinder. The detection means is mounted in or on the flat (7). When the sensor is used *e.g.* for sensing the passage of a piston rod, both the housing of the sensor and a connecting cable (5) may be disposed in a direction parallel to the travel of the piston rod.

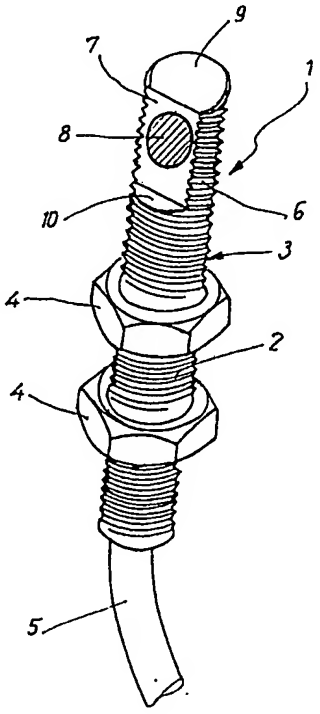

Fig. 1

GB 2 149 513 A

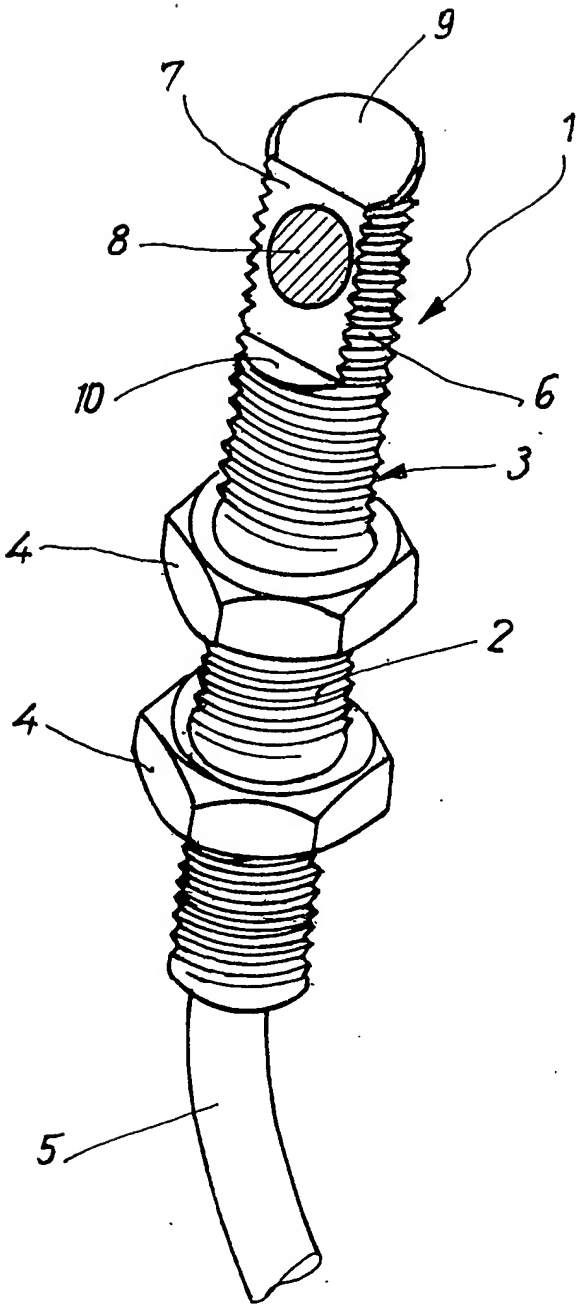

Fig. 1

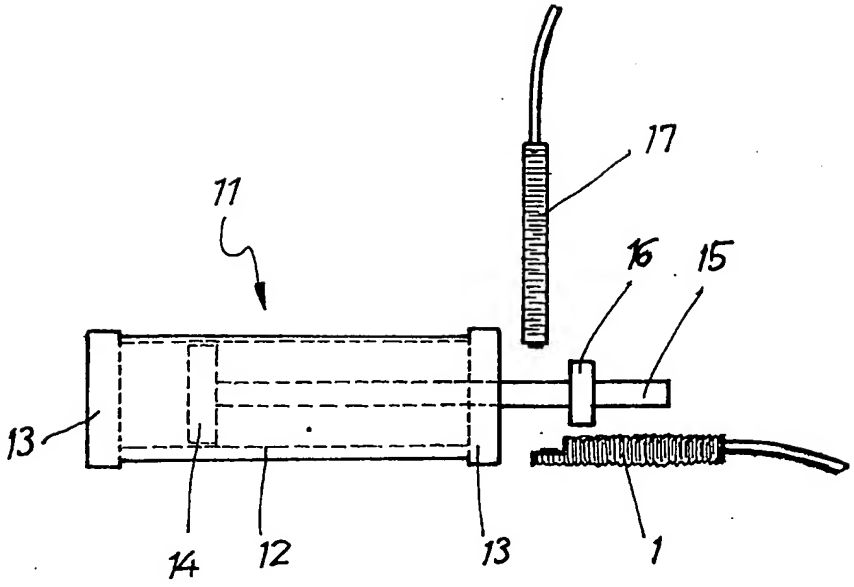

Fig. 2

SPECIFICATION

A proximity sensor

The present invention relates to proximity sensors and more particularly though not exclusively to such sensors comprising a housing and a detection means on an outer face of the housing.

Proximity sensors are employed to detect the positions of parts moving in relation to each other without any contact between the sensor and the moving part. For example, electromagnetic inductive or electromagnetic capacitive proximity sensors have been designed to repond to metallic elements within the detection range. Such proximity sensors may have a block-like housing and furthermore they may be made in keeping with an ISO Standard with a cylindrical shape for mounting in apparatus and with a metric male thread. Commonly used threads are M/8, M/12 and M/18. In known designs, the sensing or detection means is in all cases at the end face of the housing and the range or area of measurement is within a prolongation of the housing, that is to say, alined with its lengthways axis. This design necessitates such a construction of the proximity sensor that the lengthways axis of the housing is at a right angle to the direction of motion of the element to be detected and in consequence a large amount of space is taken up.

One aim of the present invention is to put an end to this shortcoming and to develop a proximity sensor that takes up very much less space for its installation.

A further object of the invention is to construct a proximity sensor that is less liable to functional disorders.

In order to effect these and further objects, the invention consists in a proximity sensor comprising a housing and a detection means at an outer face of said housing, said detection means being placed on a side of the housing so as to be directed normal to the length direction of the housing.

With such a configuration, it becomes possible for the proximity sensor to be orientated so that its long axis is parallel to the path of motion of the thing that is to be detected. In consequence it becomes possible in many applications for the overall breadth of the sensor to be made less in a direction normal to this path of motion.

In keeping with a preferred development of the invention, the housing of the proximity sensor is generally cylindrical and has a flat at one end so as to have the form of a segment of a cylinder, the detection means being at the flat limiting surface of the cylinder segment. In this design the detection means is specially well safeguarded and there is hardly any danger of the element to be detected, moving along a given path, contacting the detection means by accident. As compared with the known placing of the detection means at the end of the housing, the danger of damage is greatly cut down.

Furthermore it is an advantage if the housing is designed with a male thread, more specially in the form of a metric one in keeping with the said ISO-Standard. This design of the thread makes it possible for the proximity sensor of the present invention to be used in all those cases in which standard sensors as normally employed are presently used. It will be gathered from this that there is a great flexibility in different applications of the proximity sensor of the invention.

As part of a further teaching of the invention having to do with the connection position of the proximity sensor, it is preferred for the terminals for the electrical supply and the signal lead to run out of the end face of the housing which is opposite to the flattened end bearing the detection means. It will be seen from this that the terminals are run out of the housing in the length direction thereof, viz. they run generally parallel to the path of the element to be detected. This connection position offers a number of useful effects for many practical purposes. In the case of conventional proximity sensors, whose lengthways axis of the housing is normal to the direction of motion of the element to be detected, such a connection position is only possible if the connection is bent through 90°. If the connection is so bent, there will then always be some danger of the leads being damaged. The present invention is able to put an end to this shortcoming completely.

The proximity sensor of the invention may be designed to function by using electromagnetic detection. More specially, the sensor may be designed as an inductive or capacitive one. Such proximity sensors are characterized by a comparatively simple, sturdy construction. They respond to metals in general, something opening up a wide range of different applications. However, the detection means may be in the form of a magnetically sensitive element for example also so that it reacts to ferromagnetic materials or external magnetic fields. Last but not least, the sensor may be based on the use of optical or acoustic detection. The proximity sensor of the invention may for this reason be adapted to suit the physical properties of anything moving along a given path so that the sensor is of universal application.

In a preferred application the proximity sensor of the invention may used as a position pick-up for the control of acutuator cylinders. In this respect, the particularly useful feature comes to bear that the proximity sensor may be alined so that its lengthways axis is parallel to the direction of the stroke of the actuator and the sensor takes up very little space in a direction that is radial with respect to the axis of the actuator. A cylinder actuator equipped with a proximity sensor of the invention is for this reason very compact in construction.

Further useful effects of the invention will be seen from the following account of one working example to be seen in the figures.

Figure 1 is a perspective view of a proximity sensor or feeler in keeping with the present invention.

Figure 2 is a diagrammatic view of a set-up using the sensor of the invention to make possible a

comparison with the prior art

Referring firstly to Figure 1, the reader will be able to see a proximity sensor 1 with a generally cylindrical housing 2. The length of the housing 2 is many times greater than the diameter of the housing. The cylindrical housing 2 has a male thread 3 running from end to end, such thread preferably being a metric thread such as M/8, M/12 or M/18. The male thread 3 makes it possible for the proximity sensor 1 to be screwed into a female threaded hole in a housing, a mounting or the like. The proximity sensor has two lock nuts 4, that are screwed onto the male thread. These nuts may be used in a conventional manner for mounting the proximity sensor 1. To take an example, a mounting plate for the sensor may have a hole, in which the proximity sensor 1 is plugged with the nut 4 screwed thereon. From the free end of the proximity sensor 1 the second nut is then screwed so that the mounting plate is between the nuts. On slackening off the nuts 4, the axial position and the angle of the proximity sensor 1 about its own axis may be adjusted, before the nut 4 is tightened up again.

For the electrical connection of the proximity sensor 1, there is a cable 5 running coaxially out of the one end of the housing 2. The cable 5 contains leads for powering the proximity sensor and for conducting signals therefrom.

The end part of the housing 2 remote from the cable connection has a flat 7 so that it has the form of a cylinder segment 6. The flat 7 of this cylinder segment 6 is plane parallel to the plane containing the axis of the cylinder. The width of the flat 7 is less than the diameter of the cylinder and the axis of cylinder axis is within the segment. The male thread 3 is present on the segment 6 as well so that the nuts may be screwed along the segment with the flat as well as along the housing in the form of a complete cylinder. The length of the cylinder segment 6 is small and will generally be equal to somewhat more that the size of the detection means 8, that represents the sensing element of the proximity sensor 1.

In the case of conventional proximity sensors 1 the detection means 8 is placed at the end face 9 of the housing 2 that is remote from the cable connection. The input or sensing direction of such a detecting means is alined with the axis of the housing so that the proximity sensor has to be mounted so as to be normal to the path of motion of the body to be detected. The present invention represents a departure from this practice inasfar as the detection means 8 with its direction of signal input is normal to the axis of the housing 2 and the detection means 8 is in fact on the side of the housing. In the preferred form of the invention to be seen in figure 1, the detection means 8 is positioned on the flat 7 of the cylinder segment 6.

It is because of this placing of the detection means that the proximity sensor of the invention is able to respond to something moving along a given path parallel to the length direction of the housing 2. The detection means 8 is well safeguarded against direct contact with such objects, because if they were to collide with the housing, they would only run up against the end face 9 of the cylinder or the step 10 at the end of the cylinder segment 6. For this reason there will be no danger of damage to the detection means 8. Furthermore, the particular choice of the "field of view" of the proximity sensor 1 normal to the lengthways axis of the housing thereof makes it possible for the sensor to be very compactly mounted.

In Figure 1 the invention is to be seen as a preferred construction in the form of an inductive proximity sensor. The housing 2 accommodates an oscillator producing an electromagnetic field. The direction of propagation of this field is more or less normal to the face thereof. If now a metallic object comes into the vicinity of the detection means 8, the electromagnetic field will be damped by eddy currents produced in the metal. This damping will be sensed by the increased take up of power by the oscillator and the proximity sensor 1 will produce a corresponding control signal for a controlling network.

On generally the same lines the detector of the invention may be designed for use as a capacitive proximity sensor. A further possibility is to have an optical or acoustic emitter-detector set-up as the detecting means 8 so as to be able to detect something moving along a given path by reflexion or absorption of radiation from the sensor. The emitter may be a source of visible light or of infra-red radiation, as for example a laser. The radiation detector may be a semi-conductor detector. It is furthermore feasible to have a detector means in the form of an ultra-sonic generator and receiver. A point in common with all these possible constructions is that the radiation serving for the detection of something moving along a given path is emitted normal to the length direction of the housing, that is to say generally normal with respect to the surface of the detection means 8, that for its part is parallel to a plane of the housing 2 running parallel to the axis thereof. The range of sensitivity of the proximity sensor 1 is for this reason to the side of the housing 2.

In Figure 2 a preferred set-up for the use of the proximity sensor 1 of the invention will be seen diagrammatically. The sensor 1 is used to detect the position of part of a fluid-driven cylinder actuator 11 to control its operation. It will be seen that there is a cylinder barrel 12 of the actuator, that is shut off at its ends by two end plates 13. In the inside of the barrel 12 there is a fluid-driven piston 14 that is joined to a piston rod 15. The piston rod 15 runs through one of the cylinder end plates for the transmission of mechanical driving force to a load (not illustrated) joined with the piston rod. A pick-up ring 16 is mounted on the piston road 15 and the position of the ring is sensed by the proximity sensor 1 of the invention. The detection of the position of the pick-up ring 16 may be for the purpose of limiting the axial stroke of the piston 14 and of the piston rod 15 and reversing the supply of driving fluid to the cylinder actuator 11 when the actuator is in one end position.

The proximity sensor 1 of the present invention is mounted so that the lengthways axis of the housing is parallel to the piston rod 15. This position of mounting is made possible by the "direction of view" of the detection means 8 so as to be normal to the length direction of the housing 2. It will be clear that mounting the proximity sensor 1 in this way so as to be parallel to the piston rod 15 is responsible for a great saving in space. A conventional proximity sensor 17 with a sensing means at its one end on the other hand has to be mounted radially with respect to the axis of the piston rod 15, viz. the stroke direction of the cylinder actuator 11 so that the amount of space required is very much greater. Therefore a proximity sensor 1 in keeping with the invention and a cylinder actuator used therewith will give a much more compact sub-assembly. A further useful effect of the invention is the fact that the cable 5 runs out of the housing parallel to the stroke direction of the cylinder actuator 11. Such a direction of the cable is desired in many cases. In the prior art the cable 5 had to be bent sharply through 90° so that there was a chance of damage by kinking or chafing. In the set-up of the invention the detection means 8 is very well safeguarded against contact with whatever is to be detected and in comparison with the exposed placing of the means on the end of the cylindrical housing there is a greatly reduced risk of damage and trouble conditions caused thereby. Lastly it is to be noted that the proximity sensor 1 of the invention is quite as flexible as the conventional proximity sensor as regards possibilities of different mounting positions. It is readily possible for the proximity sensor 1 of the invention to be mounted so that it is normal to a plane containing the axis of the piston rod 2, it then being normal to the plane of Figure 2.

CLAIMS

1. A proximity sensor comprising a housing and a detection means at an outer face of said housing, said detection means being placed on a side of the housing so as to be directed normal to the length direction of the housing.

2. A proximity sensor as claimed in claim 1 wherein said housing is substantially cylindrical and towards one end has a flat which is plane parallel to a plane containing the axis of the housing, said detection means being at said flat.

3. A proximity sensor as claimed in claim 1 or claim 2 wherein said housing has a male screw thread thereon.

4. A proximity sensor as claimed in claim 2 or claim 3 comprising a least one connection means at an end of said housing opposite said end with said flat.

5. A proximity sensor as claimed in any one of the claims hereinbefore in which said detection means is inductive.

6. A proximity sensor as claimed in any one of the claims hereinbefore 1 wherein said detection means is optical.

7. A proximity sensor as claimed in any one of the claims hereinbefore wherein said detection means is acoustic.

8. A cylinder actuator for operation by fluid power and comprising a proximity sensor as claimed in any one of the claims hereinbefore for controlling its operation.

9. A proximity sensor substantially as hereinbefore described with reference to Fig. 1 of the accompanying drawings.

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